NASA Facts

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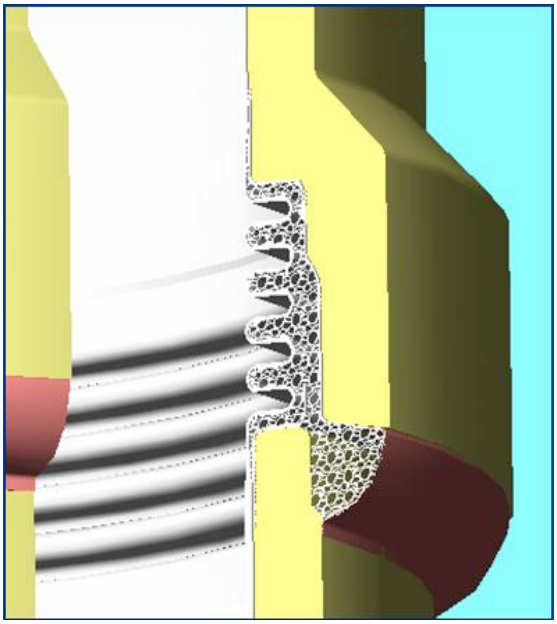
External Tank Return to Flight Focus Area

Liquid oxygen (LO2) feedline bellows

As part of the Space Shuttle Program's efforts to eliminate and minimize potential debris sources during launch and ascent, the Space Shuttle External Tank Project is redesigning part of the tank's liquid oxygen (LO2) feedline.



New LO2 configuration

The modification will eliminate the potential for ice debris from the feedline bellows, improving the overall safety of the tank.

The current configuration of the feedline bellows potentially allows ice to form during pre-launch fueling of the External Tank when moisture in the outside air contacts the cold surface of the un-insulated bellows; the cold bellows surface is caused by the minus-297-degree liquid oxygen in the feedline. Though there have been no reported losses of foam insulation from this area of the tank, photographs taken prior to launch indicate that ice can form on the bellows.

Though the liquid oxygen feedline bellows are protected by a rain-shield covered with BX-265 insulating foam, the bellows are exposed to the open air environment. When moisture in the air contacts the cold surface of the exposed bellows, ice and frost may form. If ice in this area dislodges during liftoff, it could potentially damage the Shuttle system.

There are five bellows in the liquid oxygen feedline sections that allow the feedline to move, or flex, when the feedline is being installed on the External Tank. Three of these bellows are in the portion of the feedline adjacent to the hydrogen tank.

Two of the bellows are in the intertank and are not a source for debris. These bellows allow the lines to adjust when the liquid hydrogen tank is filled and permit the feedline to adapt to the forces generated at liftoff.

The liquid oxygen feedline assembly extends externally along the right side of the liquid hydrogen tank, up to and within the intertank -- which joins the liquid hydrogen and oxygen tanks -- and down to the aft dome, or bottom, of the liquid oxygen tank. The line is approximately 70 feet long and about 17 inches in diameter.

The design solution incorporates a Thermal Protection System modification and a three-component volume fill that consists of aerogel filler between the bellows and the bellows shield and contained using a fiberglass scrim cloth which is bonded to the Thermal Protection System. Scrim is a loosely woven cloth, distinctive because there is empty space between threads.

The scrim cloth is coated with waterproofing to enhance condensate run off. The aerogel beads, produced by Cabot under the trade name Nanogel™, are treated to be completely hydrophobic – meaning they resist water. They also have low thermal conductivity -- the thermal conductivity of other bulk fill thermal insulation materials is 2 or 3 times higher -- and excellent mechanical properties in the case of compression loading. Aerogel is porous, but the pore size is approximately 20 nanometers -- two hundredths of one millionth of one meter -- making it a distinctly different category from conventional open-cell or closed-cell materials. Individual Nanogel™ particles are approximately one millimeter in diameter and flow like water, allowing for movement in the bellows.

The Thermal Protection System in the bellows area also has been modified, reshaping it to include a “drip-lip,” or additional foam that squares-off the previous configuration enhancing condensate run off from the bellows.